Biology and host specificity of *Plectonycha correntina* Lacordaire (Chrysomelidae), a candidate for the biological control of *Anredera cordifolia* (Tenore) Steenis (Basellaceae)

C. Cagnotti, F. Mc Kay* & D. Gandolfo

South American Biological Control Laboratory, USDA-ARS, Hurlingham, Argentina

Field surveys conducted in Argentina proved *Plectonycha correntina* Lacordaire (Coleoptera: Chrysomelidae) to be a promising biocontrol agent against the Neotropical perennial climber, *Anredera cordifolia* (Tenore) Steenis (Basellaceae), a serious environmental weed in Africa and Australasia. Larvae and adults feed on the leaves. The host range was evaluated by no-choice larval survival tests and adult feeding and oviposition choice tests. Sixteen plant test species were selected from the Basellaceae (4 species), Portulacaceae (4), Crassulaceae (3), Cactaceae (3) and Aizoaceae (2) families. Larval development could only be completed on species of Basellaceae (*A. cordifolia, Anredera krapovickasii* (Villa) Sperling, *Basella alba* Linné, *Ullucus tuberosus* Caldas). The other test plant species sustained larval development for less than 96 hours. In multiple-choice tests involving plant species outside the Basellaceae, both in the presence and in the absence of *A. cordifolia, P. correntina* showed an almost complete preference for its natural host. Larvae that emerged from the few eggs laid on *Talinum paniculatum* (Jacquin) Gaertner (Portulacaceae) and *Pereskia grandifolia* Haworth (Cactaceae) died within 48 hours, without feeding. In the test among the Basellaceae, feeding and oviposition preference of *P. correntina* for *A. cordifolia* and *B. alba* were significantly higher than for *A. krapovickasii* and *U. tuberosus.* In multiple-choice and paired-choice feeding and oviposition tests, and in fecundity tests, *P. correntina* displayed a significantly greater preference for Madeira vine than for *B. alba.* The results indicate that the host range of *P. correntina* is restricted to the Basellaceae, with *A. cordifolia* as its primary host. Consequently, we consider *P. correntina* a safe and promising biocontrol agent for Madeira vine in countries such as Australia and New Zealand where no other Basellaceae occur.

Key words: invasive alien, larval survival, adult feeding, biocontrol agent.

INTRODUCTION

Anredera cordifolia (Tenore) Steenis (Basellaceae), commonly known as Madeira vine, is a perennial climber in the Basellaceae, a small plant family composed of twenty species comprised of three Neotropical genera, *Anredera, Tournonia* and *Ullucus,* and one Asian-African genus, *Basella.* This family includes species of economic importance such as *Ullucus tuberosus* Caldas, cultivated for its edible tubers in the upper altitudes in the Andean region of South America, and *Basella alba* Linné, Malabar spinach, native to Africa, cultivated for its edible leaves in countries such as Peru, India, Brazil and China (Soukup 1965; Melchiorre 1985; Sperling 1987; Rousi *et al.* 1988; Brako 1993; Dequan & Gilbert 2003).

Native to southern South America, Madeira vine occurs in Bolivia, Paraguay, southern Brazil, Uruguay and northern Argentina (Brickell & Zuk 1997; Wagner *et al.* 1999). It is a fast-growing vine with succulent, heart-shaped leaves, reddish-green stems, and racemes of fragrant white flowers (Troncoso 1987). Two subspecies have been described: *Anredera cordifolia* (Tenore) Steenis subsp. *gracilis* (Miers) Xifreda & Argimon, a fruit-bearing plant with sexual reproduction, restricted to its natural distribution area, and *Anredera cordifolia cordifolia,* only propagated by aerial bulbils and underground tubers (Xifreda 1999; Xifreda *et al.* 2000).

Extensively cultivated in tropical gardens of the world as an ornamental plant, *A. cordifolia cordifolia* has become a serious environmental weed in Australia, South Africa, Hawaii, New Zealand and other Pacific Islands (Nagata 1995; Timmins & Reid 2000). Considered a 'transformer' weed, Madeira vine forms mats over trees and shrubs, disrupting forests and replacing native species in costal areas, riversides and wetlands (Timmins & Reid 2000; Vivian-Smith & Panetta 2002). *Anredera cordifolia* has a high growth rate, with stems

*To whom correspondence should be addressed.
E-mail: fmckay@speedy.com.ar

reaching up to 6 m in a growing season in warmer, more humid areas. In addition, reproduction is very successful through the prolific production of aerial bulbils and tubers, which are dispersed following disturbance of the soil or canopy. Both aerial bulbils and tubers can remain viable for long periods (Timmins & Reid 2000; Xifreda *et al.* 2000; Vivian-Smith & Panetta 2002). In Australia, aerial bulbils and tubers were able to sprout after being left in the canopy for five years after the vine was cut (Starr *et al.* 2003). All these attributes make Madeira vine a difficult weed to control through mechanical and chemical practices and suggest that it might be a suitable target for biological control.

In New Zealand, the feasibility of a biological control programme against Madeira vine has been considered (Froude 2002). Moreover, in South Africa, a leaf-feeding flea beetle, *Phenrica* sp. 2 (Chrysomelidae: Alticinae), has been evaluated as a possible biological control agent for Madeira vine (van der Westhuizen 2006).

During field surveys conducted in northern Argentina between 2002 and 2003 the leaf-feeder, *Plectonycha correntina* Lacordaire (Chrysomelidae: Criocerini), was selected as a potential candidate for the biological control of *A. cordifolia.* The Neotropical genus *Plectonycha* contains only six species, which seem to be restricted to the Basellaceae (Monrós 1947, 1959). Detailed descriptions of systematic and biological aspects of *P. correntina* were given by Bruch (1906) and Monrós (1947). Field observations and literature records mention only *A. cordifolia* as the natural host for *P. correntina* (Bruch 1906; Monrós 1947).

In this paper we present additional biological data and host specificity studies on *P. correntina,* and discuss its potential as a biological control agent against Madeira vine.

MATERIAL AND METHODS

Biology of Plectonycha correntina

Studies were conducted at the USDA-ARS South American Biological Control Laboratory (SABCL), Hurlingham, Buenos Aires, Argentina, between 2002 and 2004. Cultures of *P. correntina* were established at the laboratory from adults, pupae and mature larvae collected on *A. cordifolia* plants growing on suburban fences in Lujan and Hurlingham, Buenos Aires Province. Experiments were conducted in controlled environment chambers at 25 ± 1 °C and 60 ± 5 % relative humidity, with a 14:10 L:D photoperiod.

The adults and larvae were fed with bouquets of freshly cut leaves of *A. cordifolia,* and kept in 0.5-litre clear plastic containers with moist tissue paper. Every 48 hours, the bouquets were replaced and eggs were harvested and placed in Petri dishes for emergence. Newly hatched larvae were reared individually on excised *A. cordifolia* leaves. The head capsule width of the larvae was measured daily to establish number and duration of larval instars. The duration of the pupal stage was also recorded. Adult longevity and fecundity were estimated from eight pairs of newly emerged *P. correntina.* Each pair was maintained as described above. Every 1–3 days, bouquets were replaced and eggs were removed and counted. An experiment was terminated when the female died; dead males were replaced. For each replicate, the pre-oviposition period, total number of eggs deposited and longevity of females was recorded.

The values of the different biological parameters are expressed as mean ± standard deviation throughout.

Host range of Plectonycha correntina

The host range of *P. correntina* was determined by conducting no-choice larval survival tests and adult choice tests.

Larval survival tests

A total of 16 plant species was tested, selected on the basis of taxonomic relatedness to *A. cordifolia,* economic importance, and availability (Table 1). Ten newly hatched, unfed larvae were placed in a Petri dish (5.5 cm diameter) on leaves of each individual plant in no-choice tests. The Petri dishes were maintained under controlled conditions (25 ± 1 °C; 60 ± 5% RH; 14:10 L:D). After 2–3 days the larvae were transferred to potted plants that were kept outdoors in 90 cm^3 cages with screen walls to prevent predation. Late-instar larvae were transferred to 500 ml plastic jars containing a layer of moist peat moss to pupate. These jars were kept under the same controlled conditions until adult emergence. Ten replicates were carried out for each test plant species. Adult emergence for all test plants were compared using a single-factor ANOVA followed by a Tukey test (Sokal & Rohlf 1981).

Adult multiple-choice feeding-oviposition tests

Adult feeding and oviposition preference of *P. correntina* was evaluated conducting choice

Table 1. Plant species used in host specificity testing of *Plectonycha correntina.*

Test plant	Status	Common name (English/Spanish)	Host specificity studies (number of replicates)		
			No-choice[a]	Multiple-choice[b]	Paired-choice[c]
Basellaceae					
Anredera cordifolia	Native	Madeira vine/enredadera del mosquito	10	12	5
A. krapovickasii	Native		10	6	–
Ullucus tuberosus	Native	Ulluco/papa lisa	10	6	–
Basella alba	Exotic	Malabar spinach	10	6	5
Portulacaceae					
Talinum paniculatum	Native	Jewels of Opar/María gorda	10	12	–
Portulaca oleracea		Purslane/verdolaga	10	12	–
P. grandiflora	Exotic	Moss rose/flor de seda	10	6	–
Portulacaria afra	Exotic	Elephant bush/planta de la Moneda	10	–	–
Cactaceae					
Pereskia aculeata	Native	Barbados gooseberry/ camilia blanca	10	6	–
P. grandifolia		Rose cactus	10	9	–
P. sacharosa	Native	Sacharosa/rosa salvaje	10	6	–
Crassulaceae					
Crassula ovata	Exotic	Jade plant	10	6	–
Kalanchoe daigremontiana	Exotic	Mother of thousands/ espinazo del diablo	10	6	–
K. blossfeldiana	Exotic	Christmas kalanchoe/ kalanchoe	10	6	–
Aizoaceae					
Aptenia cordifolia	Exotic	Ice plant	10	–	–
Mesembryanthemum sp.	Exotic	Ice plant/rayito de sol	10	6	–

[a]10 larvae per replicate; [b]16 pairs of adults per replicate; [c]16 pairs of adults per replicate.

tests that included and excluded the target weed *A. cordifolia.* First, *A. cordifolia* was combined with plants in related families, excluding the Basellaceae. In the second set of experiments, only species in close plant families other than Basellaceae were used. These experiments were conducted in 90 cm^3 outdoor screen cages. In each experiment, 4–5 potted plants, 35–50 cm high, with similar foliage area were placed in a circle within the cage. Sixteen beetle pairs were kept in the cage for 96 hours. There were three replicates for each set of experiments. The host choice behaviour was narrowed down yet further in another multiple-choice test that included *A. cordifolia* and three other basellaceous species: *Anredera krapovickasii, B. alba* and *Ullucus tuberosus.* The experiment was replicated six times under the conditions described above. At the end of the testing period, the number of eggs, the leaf area consumed and the number of adults found on each plant were recorded. The results were compared using the nonparametric Friedman test and multiple comparisons (Connover 1999).

Adult paired-choice feeding-oviposition tests

Paired-choice feeding and oviposition tests were conducted to evaluate the preference of *P. correntina* for *B. alba* in the presence of its natural host *A. cordifolia.* For each replicate, two potted plants of each plant species were arranged in a square inside 90 cm^3 cages kept in outdoor conditions. Sixteen pairs of *P. correntina* were released in the centre of the cage. The experiment was replicated five times. After 96 hours, the number of eggs, the leaf area consumed and the number of adults on each plant was recorded. These parameters were

Table 2. Life stage duration and larval head capsules width of *Plectonycha correntina* on *Anredera cordifolia*.

Stage	*n*	Life stage duration (days)		Head capsule width (mm)	
		Mean ± S.D.	Range	Mean ± S.D.	Range
Egg	20	5 ± 0.4	5–6		
L I	20	2.3 ± 0.5	2–3	0.33 ± 0.01	0.31–0.34
L II	17	2.4 ± 0.5	2–3	0.46 ± 0.01	0.46–0.48
L III	17	2.2 ± 0.4	2–3	0.66 ± 0.02	0.65–0.70
L IV	17	3.1 ± 0.3	3–4	0.95 ± 0.01	0.94–0.96
Pupa	15	19.8 ± 1	19–21		
Adult	8	75.6 ± 39.8	20–130		

compared using the nonparametric Wilcoxon matched pair test (Sokal & Rohlf 1981; Connover 1999).

Adult longevity and fecundity test

Fecundity of *P. correntina* was assessed on all test plant species that were accepted for oviposition in the choice test (*A. cordifolia, A. krapovickasii, B. alba, T. paniculatum* and *P. grandifolia*). In each replicate, one pair of newly emerged adults was placed in a 500 ml plastic container with moist tissue paper. Each pair was fed bouquets of excised fresh leaves which were inserted in a small cup with wet cotton. The bouquets were replaced every 48 hours, and the eggs were removed and counted. A replicate was ended when the female died; if the male died first it was replaced. Eight replicates were performed for each test plant. The variables recorded were the pre-oviposition period, the total number of eggs and female longevity. The fecundity data was compared using a parametric *t*-test for independent samples on $\log_{10}$-transformed data; the pre-oviposition period and female longevity were analysed using a nonparametric Mann-Whitney test, and a nonparametric Kruskal-Wallis test, respectively (Sokal & Rohlf 1981; Connover 1999).

RESULTS

Biology of *Plectonycha correntina*

Females deposited egg in groups of eight to fifteen on the abaxial side of the leaf. The eggs were yellowish and cylindrical (0.80 ± 0.01 mm long; 0.30 ± 0.01 mm wide; mean ± S.D.; n = 10) and were deposited in two rows at an oblique angle resembling a fish bone pattern. The mean incubation period ranged from five to six days (Table 2).

Four instars of *P. correntina* were clearly distinguished by their head capsule width (Table 2). The newly hatched larvae had a white ovoid-shaped body, with a distinctive dark brown head and pronotum. The first three instars behaved gregariously. As reported by Bruch (1906) and Monrós (1947), larvae became covered with a transparent gelatinous substance once they started feeding. The larvae were mostly found on the underside of leaves. The first instars fed on the surface of the fleshy leaves, leaving translucent rounded spots of leaf cuticle tissue, while the later instars left rounded holes all over the leaves. The voracious feeding habits of *P. correntina* mature larvae on *A. cordifolia* were recorded not only during the host specificity tests, but also while culturing insects on outdoor plants. As the larvae developed, they became almost indistinguishable under the gelatinous substance mixed with frass and exuviae. As described by Bruch (1906), fourth-instar larvae disaggregated and moved to the lower parts of the plant, where they discarded the dark brown gelatinous substance covering their bodies. Yellow naked larvae burrowed into the soil to pupate. Under laboratory conditions, the larvae pupated on the bottom of the container in a foamy cocoon made of white mouth secretion. When insects were reared on potted plants, cocoons were found in soil crevices near the roots of the plant. The time from oviposition to pupation ranged from 14 to 19 days (Table 2). The time from cocoon formation to adult emergence was 19.8 ± 1.01 days (n = 15).

The body (5.2 ± 1 mm long; 2.1 ± 0.3 wide) and legs of *P. correntina* adults were black and the pronotum and elytra reddish brown (Bruch 1906; Monrós 1947). Black elytral spots (up to seven) were frequently observed, although they can be absent. Bruch (1906) and Monrós (1947) described this trait as intraspecific variation. Mating pairs of *P. correntina* representing different elytral patterns

Table 3. Larval survival no-choice test of *Plectonycha correntina* on several species. Means were compared by one-way ANOVA ($F_{(n=40;\ d.f.=3)} = 4.24$; $P = 0.01$); those followed by different letters are significantly different ($P < 0.05$; Tukey HSD *post hoc* test).

Test plant species	Number of replicates	Number of larvae tested	Mortality within 96 hours (%)	Adults emerged per replicate (mean ± S.D.)
Basellaceae				
A. cordifolia	10	100	17	6.80 ± 1.55^{a}
A. krapovickasii	10	100	31	4.90 ± 1.66^{a}
U. tuberosus	10	100	42	4.90 ± 2.69^{a}
B. alba	10	100	29	3.50 ± 2.22^{b}
Portulacaceae				
T. paniculatum	10	100	100	0
P. oleracea	10	100	100	0
P. grandiflora	10	100	100	0
Cactaceae				
P. aculeate	10	100	100	0
P. grandifolia	10	100	100	0
P. sacharosa	10	100	100	0
Crassulaceae				
C. ovata	10	100	100	0
K. daigremontiana	10	100	100	0
K. blossfeldiana	10	100	100	0
Aizoaceae				
Aptenia cordifolia	10	100	100	0
Mesembryanthemum sp.	10	100	100	0

were frequently observed both in the laboratory and in nature.

In the field, the adults were usually found on the underside of the leaf, and dropped off easily when disturbed. The pre-oviposition period was 6.1 ± 1.4 (n = 10) days, the mean number of eggs deposited per female was 555 ± 292 (n = 10) and the longevity of females was 75.6 ± 39.8 days (n = 10).

Host range of *P. correntina*

Larval survival tests

Plectonycha correntina larvae were only able to complete their development on basellaceous test plants (Table 3). The number of adults obtained from *B. alba* was significantly lower than those registered on the three other Basellaceae. Test plant species outside the Basellaceae registered 100 % larval mortality within the first 96 hours of the testing period, and in a few cases a little damage was observed.

Adult multiple-choice feeding-oviposition tests

In the test involving plant species outside the family Basellaceae in the presence of *A. cordifolia*, *P. correntina* showed a clear feeding and oviposition preference for its natural host (Table 4). Only some feeding damage was observed on *P. grandifolia* and very few eggs and some nibbling were registered on *T. paniculatum.* In the absence of *A. cordifolia,* similar levels of feeding damage and number of eggs were registered on *T. paniculatum* and *P. grandifolia* (Table 5). However, larvae that emerged from eggs laid on these two plant species, when in the presence and in the absence of *A. cordifolia,* did not feed and died within 48 hours of emergence.

In the test where *P. correntina* was exposed only to plant species of the Basellaceae, feeding and oviposition preference of *P. correntina* for *A. cordifolia* and *B. alba,* were significantly higher than for *A. krapovickasii* and *U. tuberosus* (Table 6). Although both the number of eggs and the leaf area consumed were higher on *A. cordifolia* than on *B. alba,* values did not differ significantly.

Adult paired-choice feeding-oviposition tests

Plectonycha correntina displayed a clear feeding and oviposition preference for *A. cordifolia* (Table 7). Although feeding and oviposition did

Table 4. Multiple-choice feeding and oviposition test of *Plectonycha correntina* with *Anredera cordifolia.* The letters A, B or C show the different array of tested plants used in every test. Within every array (A, B or C) the test species followed by different letters (a, b, c) are significantly different (Friedman test, $P < 0.05$).

Tested plants	Number of replicates	Number of insects tested	Leaf area consumed (mm^2)	Number of eggs per replicate (mean ± S.D.)	Total number of eggs (mean ± S.D.)
Basellaceae					
A. cordifolia					
A	3	48	1542.00 ± 521.49^a	177.0 ± 121.9^a	531
B	3	48	666.67 ± 186.79^a	114.0 ± 50.4^a	342
C	3	48	980.00 ± 402.06^a	110.3 ± 44.5^a	331
Portulacaceae					
T. paniculatum					
A	3	48	1.33 ± 2.31^b	4.7 ± 6.4^b	14
B	3	48	5.00 ± 6.24^b	0^b	0
P. oleracea					
B	3	48	0^c	0^b	0
C	3	48	0^c	0^b	0
P. grandiflora					
C	3	48	0^c	0^b	0
Cactaceae					
P. aculeate					
A	3	48	0^b	0^b	0
P. grandifolia					
C	3	48	4.67 ± 5.03^b	0^b	0
P. sacharosa					
A	3	48	0^b	0^b	0
Crassulaceae					
C. ovata					
B	3	48	0^c	0^b	0
K. daigremontiana					
A	3	48	0^b	0^b	0
K. blossfeldiana					
C	3	48	0^c	0^b	0
Aizoaceae					
Mesembryanthemum sp.					
B	3	48	0^c	0^b	0

occur on *B. alba,* the values recorded were five- and threefold lower, respectively, compared to the corresponding values for *A. cordifolia.*

Adult longevity and fecundity tests

Only females that were fed with *A. cordifolia* and *B. alba* laid eggs (Table 8). Females that were fed with *A. krapovickasii, T. paniculatum* and *P. grandifolia* died after five to seven days without ovipositing.

The pre-oviposition period was significantly shorter on *A. cordifolia* (6.1 days ± 1.4) than on *B. alba* (21.6 days ± 20.4), and the number of eggs laid on *A. cordifolia* (555.1 ± 292.9) was significantly higher than on *B. alba* (126.4 ± 107.3) (Table 8). Although females reared on *A. cordifolia* lived longer than those females fed with *B. alba,* values did not differ significantly.

DISCUSSION

Aspects of the biology of *P. correntina* such as the high fecundity and longevity of adults, short generation times and the feeding damage of

Table 5. Multiple-choice feeding and oviposition test of *Plectonycha correntina* without *Anredera cordifolia.* The letters A, B or C show the different array of tested plants used in every test. Within every array (A, B or C) the test species followed by different letters (a, b, c) are significantly different (Friedman Test $P < 0.05$).

Tested plants	Number of replicates	Number of insects tested	Leaf area consumed (mm^2) (mean ± S.D.)	Number of eggs per replicate (mean ± S.D.)	Total number of eggs
Portulacaceae					
T. paniculatum					
A	3	48	5.67 ± 3.06^a	2.7 ± 4.6^a	8
B	3	48	15.33 ± 6.66^a	5.7 ± 9.8^a	17
P. oleracea					
B	3	48	0^b	0^a	0
C	3	48	0^b	0^a	0
P. grandiflora					
C	3	48	0^b	0^a	0
Cactaceae					
P. aculeate					
A	3	48	8.33 ± 14.43^a	0^a	0
P. grandifolia					
A	3	48	67.33 ± 6.86^a	2.0 ± 3.6^a	6
C	3	48	0.33 ± 0.58	7.00 ± 7.00	26
P. sacharosa					
A	3	48	0^a	0^a	0
Crassulaceae					
C. ovata					
B	3	48	0^b	0^a	0
K. daigremontiana					
A	3	48	0^a	0^a	0
K. blossfeldiana					
C	3	48	0^b	0^a	0
Aizoaceae					
Mesembryanthemum sp.					
B	3	48	0^b	0^a	0

larvae and adults, suggest that it has potential as an agent for the biological control of *A. cordifolia.* In addition, the fact that the larvae of *P. correntina* live covered by a slimy mass of excremental material described as a protective adaptation in other Criocerinae (Crowson 1981), could help avoid parasitism and predation and improve the effectiveness of *P. correntina* on *A. cordifolia.* Chemical studies of similar larval integumental secretion of the *Melaleuca quiquenervia* (Cav.) (Myrtaceae) biological control agent *Oxyops vitiosa* Pascoe (Coleoptera: Curculionidae), revealed the presence of plant-derived compounds for defence against generalist predators (Wheeler *et al.* 2002).

Host specificity tests clearly showed that the host range of *P. correntina* is restricted to the Basellaceae. In larval survival tests, no adults of *P. correntina* could be reared from any test plant other than the Basellaceae. Moreover, the larvae exposed to these plant species died within 96 hours of testing, almost without feeding. A similar degree of acceptance was displayed by the flea beetle, *Phenrica* sp. 2 (Coleoptera: Chrysomelidae), another possible biological control agent for Madeira vine in South Africa. In larval survival tests, *Phenrica* sp. 2 developed only on the basellaceous species *B. alba* and *U. tuberosus* and the portulacaceous species *T. paniculatum* (van der Westhuizen 2006).

In the multiple-choice test involving plant species outside the Basellaceae but including *A. cordifolia, P. correntina* showed an almost complete preference

Table 6. Multiple-choice feeding-ovipostion test of *Plectonycha correntina* with Basellaceae species. Test species followed by different letters are significantly different (Friedman test and multiple comparisons, $P < 0.05$).

Test plant species	Leaf area consumed	Number of eggs (mean ± S.D.)	Total number of eggs (mean ± S.D.)
A. cordifolia	774 ± 683.78^{a}	47.2 ± 50.5^{a}	283
A. krapovickasii	22.67 ± 24.44^{b}	2 ± 4.9^{b}	12
U. tuberosus	2.42 ± 4.13^{b}	0^{b}	0
B. alba	211.5 ± 235.77^{a}	32.8 ± 30.2^{a}	197

for its natural host, although some feeding damage was observed on *P. grandifolia* and very few eggs and some nibbling were registered on *T. paniculatum*. Multiple-choice tests where the natural host is not included are designed to detect other plants species that could act as alternate host (Heard & Van Klinken 1998). The absence of *A. cordifolia* had very little impact on the feeding damage and number of eggs registered on *T. paniculatum* and *P. grandifolia* despite the increase in pressure of *P. correntina.* The fact that the larvae of *P. correntina* that did emerge from eggs laid on *T. paniculatum* and *P. grandifolia,* both in the presence and in the absence of *A. cordifolia,* died soon after emergence, discounts the possibility that these plant species could serve as alternative host of *P. correntina.*

The fecundity tests indicate that *T. paniculatum* and *P. grandifolia* are not suitable alternate hosts of *P. correntina,* as adults reared on these two plant species died within seven days of testing without ovipositing. These results confirm that *T. paniculatum* and *P. grandifolia* could not sustain a viable *P. correntina* population.

In larval survival tests, *P. correntina* larvae were able to reach the adult stage on all the Basellaceae tested. The number of adults obtained on *B. alba* was significantly lower than the number of adults obtained on the other species (*A. cordifolia, A. krapovickasii* and *U. tuberosus*). However, in the multiple-choice tests where only Basellaceae were included, feeding and oviposition preference of *P. correntina* for *A. cordifolia* and *B. alba,* were significantly higher than for *A. krapovickasii* and *U. tuberosus.*

Table 7. Paired-choice feeding and oviposition test of *Plectonycha correntina* on *Anredera cordifolia* and *Basella alba.* Test species followed by different letters are significantly different (Wilcoxon matched pair test, $P < 0.05$).

Test plant species	Leaf area (mean ± S.D.)	Number of eggs consumed (mean ± S.D.)
A. cordifolia	987.30 ± 514.43^{a}	69.9 ± 42.2^{a}
B. alba	182.20 ± 263.75^{b}	19.3 ± 23.9^{b}

Although *P. correntina* was able to complete larval development on *A. krapovickasii,* fecundity and longevity tests showed that *P. correntina* neither fed nor laid eggs on *A. krapovickasii,* and died within five days. These results clearly indicate that *A. krapovickasii* should not be considered as an alternate host to support viable *P. correntina* populations.

Even though *P. correntina* did not show significant differences between *A. cordifolia* and *B. alba* in the multiple-choice tests, significantly lower values were registered for the latter species during

Table 8. Adult longevity and fecundity test of *Plectonycha correntina* on basellaceous species. Means followed by different letters are significantly different ($P < 0.05$).

Tested plants	Number of eggs/female (mean ± S.D.)	Pre-oviposition period (days) (mean ± S.D.)	Longevity of females (days) (mean ± S.D.)
A. cordifolia	555.1 ± 292.9^{a}	6.1 ± 1.4^{a}	75.6 ± 39.8^{a}
A. krapovickasii	0	–	5.3 ± 0.7^{b}
B. alba	126.4 ± 107.3^{b}	21.6 ± 20.4^{b}	61.6 ± 33.0^{a}
T. paniculatum	0		6.0 ± 2.8^{b}
P. grandifolia	0	–	7.0 ± 4.7^{b}

the paired-choice test. The fecundity and longevity of females of *P. correntina* on *A. cordifolia* also differed significantly from *B. alba.*

Analysing the present results as a whole, it is clear that the host range of *P. correntina* is restricted to Basellaceae with *A. cordifolia* as its primary host plant. However, *B. alba* and *U. tuberosus* should not be discounted as alternative host plants.

The safety of *P. correntina* as a biological control agent for *A. cordifolia* in South Africa deserves some consideration. *Ullucus tuberosus* and *B. alba,* the two Basellaceae that could not be discarded as alternative hosts of *P. correntina,* have been introduced in South Africa (Sperling 1987; Jordaan 2000, 2003; van der Westhuizen 2006). As *B. alba* is utilized in other parts of Africa, and there are no guarantees that a biological control agent released in one country will not move into other countries, we recommend running open-field trials including *A. cordifolia* and *B. alba* in order to clarify and refine the present laboratory results.

The only indigenous *Basella* species, *B. paniculata* Volkens, reported as endemic to the northeast part of South Africa (Sperling 1987; Jordaan 2000, 2003), could not be included in the host specificity testing of *Phenrica* sp. 2, owing to its marginal distribution and inconspicuous nature (van der Westhuizen 2006). Considering *P. correntina*'s degree of acceptance of *B. alba,* we recommend that *B. paniculata* be included in the test plant list if the release of *P. correntina* in South Africa is ever considered.

In countries like Australia and New Zealand, where there are no indigenous Basellaceae, and neither *U. tuberosus* nor *B. alba* are cultivated (R.E. McFadyen, pers. comm.; Froude 2000), we recommend *P. correntina* as a safe and promising biocontrol agent for Madeira vine.

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